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SALARIES

DURING the past ten years and more the question of adequate remuneration of gas engineers and managers, their deputies, and technical staff generally, has been under discussion by the Gas Industry. We have published many views, taken note of the various moves which have been made, and have written much on the whole problem. That it is complicated is apparent. There are the posts of engineer, that of manager or general manager, and the combined post of engineer and manager; with company owned, the post of secretary in addition can further complicate matters. There is, however, an insistent demand for some datum line; and under present conditions the Gas Industry is allowing to go to waste a good deal of the ability, energy, and enthusiasm which are to be had from the young men in its ranks. We recall the remarks of Sir Frederick West, who has devoted so much time towards the finding of a solution to the problem, in his William Young Memorial Lecture in the year before outbreak of war: "Initiative, ability, and intellectual capacity can only be secured if the monetary reward is sufficient and compares favourably with that in other walks of life. It is certain that the Gas Industry will fail to attract the right type of man if the remuneration offered is so meagre as to be almost an insult to his intelligence and self-respect."

It is well known that the Institution of Gas Engineers has given much thought to this all-important question of salaries, and that it has acquired a great amount of information. The Institution, however—and it fully realizes the uneasiness which exists regarding conditions of employment and remuneration of gas engineers—is debarred by its Royal Charter from negotiating in regard to the conditions of individuals and can only discuss these matters in a very general matter. Hence the importance of the latest move—a Gas Engineers' National Guild, which in fact is in process of formation. We have received full particulars of this proposed Guild and are glad that the matter is not of the "hush-hush" variety. The objects of the Guild are to secure, for qualified gas engineers, executive and technical officers of gas undertakings, reasonable conditions of service, adequate salaries in accordance with their qualifications and responsibilities, pensions, compensation, and so on, and to negotiate with employers. It is claimed with justice that such negotiations may prove of the greatest importance in view of the proposed changes in ownership of the Industry. Certainly the time is opportune to get the organization firmly established, and it is satisfactory to know that the scheme has already met with good response.

THE CONTINUOUS VERTICAL RETORT

INCOMPARABLY the most outstanding development in gas-making plant in the last 40 years has been that of the continuous vertical retort, and it is satisfactory to note that it is the product of British inventive genius. But with the shedding of the shackles imposed by the candle-power standard and the freedom acquired within the enabling Act of 1920, to select whatever calorific value might be most economical, the continuous vertical took a new lease of life with the introduction of continuous steaming. We are so used to this now that we may overlook the essential difference between steaming for one or more hours after carbonization in the intermittent and steaming throughout the whole 24 hours in the continuous vertical. Everyone appreciates too, that by varying the amount of steam admitted to the retort the products of dry distillation are diluted by the addition of more or less water-gas resulting in the production of mixed gas at any desired though lower calorific value and increased in volume by that of the "added gas."

Here then is a very flexible instrument in the hand of the expert retort-house engineer. But it has been said that this flexibility is capable of abuse, and it is well to look into the allegation. In the first place it is clear that there must be a pretty delicate balance between the number of factors if the optimum results under any given conditions and with any given coal are to be obtained. These factors include the characteristics of the coal, the temperature of the combustion chambers and the distribution of temperature over the vertical length of the retort, the speed of transit of the coal through the retort, the quantity and temperature of steam admitted, all in relation to the calorific value of gas which it is desired to produce. And it is open to suspicion whether it is not in the neglect of the import of the last phrase of the foregoing sentence that the abuse referred to has taken place. We are not sure, indeed, whether even the highest authorities have given full weight to this point.

Much work has been done in carbonizing different coals with different rates of steaming in continuous verticals, but some of this work appears to have missed the problem with which the operator is confronted in the retort-house in every-day practice. In this problem the two basic factors are first the coal available, and secondly, the calorific value of the gas to be made. Experienced operators know that a retort bench can be operated to give either the maximum make per ton of coal or the maximum production per retort. And he is in a position to find the necessary conditions for either of these optima. What he is not, generally, in a position to do is to ascertain whether at another calorific value he could get results which would justify the selection of another calorific value—that is to say, which would favour an alteration in the declared value selected by his under-

taking. This can only be done effectively in a research plant which is free to vary the calorific value.

What, then, has been done in research plants? One of the most complete series of tests was that carried out at the Fuel Research Station on Mitchell Main coal. Unfortunately, those tests can only be regarded as preliminary or exploratory. Their usefulness is seriously impaired by the fact that the investigators imposed upon themselves restrictions which do not apply in practice. Their aim—and in that aim they were, of course, brilliantly successful—was to ascertain what would happen if one only of the factors, the quantity of steam admitted to the retort, was varied. Temperatures within the setting and throughput of coal were kept constant. The results are not without interest. But they do not give the information required in the retort house, which briefly is, what should be the throughput, what the temperatures, and what the proportion of steam to coal to give the maximum make per ton at a series of calorific values and/or the maximum production per retort.

NEED FOR NEW INVESTIGATIONS

IN short, there is still needed a whole new series of investigations with a number of standard coals, varying not only in chemical but in physical (that is, grading) characteristics. Such a series of investigations would be lengthy and costly. It is clear, for instance, that one five (or three) day run with each set of conditions would not be sufficient. Several such runs might be necessary before the best conditions were found. It is well to try to estimate just what we are asking for. It may be assumed that there are at least seven or eight standard gas-making coals available in the several coalfields of Great Britain. Each of these is obtainable in three or four sizes. So that we have from 21 to 34 different coals which should be investigated. Calorific values need not be graduated anything like so closely as would be suggested by the inordinately long list of values which are at present declared, but if we contented ourselves with six values stepped in 25 B.Th.U. from 525 to 400, we are confronted with careful determinations involving three or four test periods for each of something like 200 cases.

That would cost a lot of money, but we suggest that the resources of the Gas Research Board could be employed in much less useful work. It may be objected that there must be information in the possession of operators, both those employed by gas undertakings and those representing the leading constructional engineers, which gives the necessary guidance. But we doubt whether this is the case. True there is the dictum, sometimes quoted, that a continuous vertical retort should make an equal number of therms at all values within the practical range. But useful as this dictum is in the design of plant we doubt whether it is more than an empirical approximation. It rather represents a minimum to be expected than a maximum to be aimed at. And we know, too, that it is frequently necessary, and often very useful, to operate a vertical retort at a comfortable rate, less than the maximum possible, in order to leave a safe margin for stepping-up to meet the emergency load. Indeed, several works with low storage capacity have found this an extremely valuable characteristic of the continuous vertical, giving a flexibility which is by no means open to the charge of abuse. Retorts can be used in this way, to make good a defect in storage and even to prolong their life. The task is the easier because the holder is required only to store against fluctuating demand and has not to deal with variations in quantity and quality of supply. There is a nice balance, only to be found in practice, between economy in coal and economy in plant, and everybody may not agree with our view that generally the former is to be preferred.

There is also the check on the make per ton at a given calorific value provided by Dr. Pexton's H.E.V. But here, again, it is not conclusively known whether a constant H.E.V. represents the best that can be done in every given case. More than one test period needs to be devoted to every particular set of conditions to ascertain whether the optimum has been reached. It is possible that there is a definite calorific value at which a given continuous vertical will give the best H.E.V. We do not say that this should be the sole determining factor in the selection of a declared value, but we do say that it should play an important part in the selection. It is certain that a retort of one size gives better results per unit of capacity, or maybe just easier working, than a retort of another size, particularly with coals which are somewhat "difficult." This size should be ascertained and adopted for the treatment of coals of that type.

Among the very many problems awaiting the attention of the Gas Research Board when it is adequately staffed, equipped, and financed, here is one worthy of its steel.

Diary

Sept. 12.—North British Association of Gas Managers: Annual General Meeting at Rothesay.

Sept. 16.—London and Counties Coke Association: Finance Committee, 11 a.m.; Executive Committee, 11.30 a.m.; Central Committee, 1.30 p.m.; Gas Industry House.

Sept. 26.—Wales and Monmouthshire Association of Gas Engineers and Managers. General Meeting, Grand Pavilion, Porthcawl, 10.30 a.m.

Oct. 11.—National Federation of Gas Coke Associations: National Technical Committee, Gas Industry House, 10.30 a.m.

Oct. 11.—Solid Smokeless Fuels Federation Technical Committee, Gas Industry House, 2.30 p.m.

Oct. 21.—London and Counties Coke Association: Finance Committee, 10.30 a.m.; Executive Committee, 11 a.m.; Central Committee, 12 noon; Annual Luncheon, 1 p.m. for 1.15 p.m.; Annual General Meeting, 2.45 p.m. Grosvenor House, Park Lane, W.1.

Nov. 26-27.—Institution of Gas Engineers: Autumn Research Meeting.

Gas Welding of Magnesium Alloys

With the growing importance of the applications of light alloys to the engineering industries, special interest attaches to a report "Technique for the Gas Welding of Magnesium Alloys" issued by the British Welding Research Association. Magnesium alloys proved their worth during the war and many current developments in industry would suggest that more will be heard of them in the future. The publication just issued is a memorandum prepared by a joint committee of the British Non-Ferrous Metals Research Association and the British Welding Research Association on Fusion Welding of Magnesium-rich Alloys.

It is pointed out that the readiness and ease with which magnesium—1.5% manganese alloy may be welded renders possible the construction of complicated assemblies, but to achieve that most advantageously the designer must make adequate use of all available forms of the metal, that is to say, tubes, extrusions, sheet, &c. Particulars are given of design, edge preparation, setting up, manipulation, and finishing and protective treatment, including removal of fluxes, hammering, chemical cleaning, chromating, painting, and temporary protection. An outline is given of the properties of magnesium affecting welding technique, the effect of the composition of the alloy on welding behaviour, notes on the welding flame, the flux and welding rods. Of special interest are references to weld defects and inspection and testing. The appendix includes details of chromating treatment.

Copies of "Technique for the Gas Welding of Magnesium Alloys" may be obtained (2s. post free) on application to the Director of Research, British Welding Research Association, 29, Park Crescent, W.1.

Complaints in Scotland still maintain that gas coal now being supplied is inefficient and unsuitable for the purpose, involving gas-works not only in extra work but in added costs. The position, though not new, is interesting in that repeated complaint has not so far achieved the purpose of effecting any improvement. An allegation some weeks ago that current deliveries were producing only 75% of gas per ton of coal, as against pre-war deliveries, received the normal routine answer that any such problem would undoubtedly be indicated by the gas company concerned to the Ministry of Fuel and Power—an answer which quite ignores the actual experience of the average gas plant and discourages managements from anticipating that relief can be hoped for.

Letters to the Editor

Aerated Burners of High Stability

DEAR SIR,—The comment by Mr. Greaves in your issue of Aug. 28 is particularly valuable in view of his wide experience in the manufacture of this type of burner. The last point he makes is certainly a correction on point of fact which invites further investigation. It is conceivable that a flame, if pushed through a small hole sufficiently quickly, might retain enough heat for combustion to continue, while at a lower velocity extinction would be certain.

I am, however, surprised to learn that the approach angle to the burner throat should be important. I cannot for the moment see why this should affect the performance unless it influences the direction of flow of the whole body of air flowing into the burner. Most of the diagrams in Fig. 8 (" JOURNAL " of Aug. 7, p. 232) have right-angle approaches, because this seemed the simplest arrangement.

Finally, Mr. Greaves, in his point 2, states that self-extinguishing injectors can function irrespective of flame ports. This is certainly true, but the burner which " wants to light back and can't " produces a series of explosions in the burner tube which is far from desirable. Perhaps it is only better than ordinary lighting back in so far as attention of the operator is immediately called to a burner in this condition. In order to obtain a burner which is stable, however, it is not sufficient by itself to have a good injector—the flame ports must be of suitable size also.

Yours faithfully,

L. T. MINCHIN.

25a, Thurlow Road,
London, N.W.3.
Aug. 30, 1946.

High-Pressure Gasholders

DEAR SIR,—I do wish that Mr. Milbourne would give an answer to my straightforward question, and not quibble about the exact spot which shall be struck by a 7 lb. hammer. Use the hammer as on the welded seam, but in close proximity to the riveted seam.

A further question. Does Mr. Milbourne agree with me that in the construction of a riveted high-pressure holder, all defective rivets found either during construction or on test, shall be replaced by sound and perfectly tight rivets, no caulking being permissible on any rivet ?

I can assure Mr. Milbourne that the riveted high-pressure holder mentioned in my last letter was correctly designed in every particular. The fault lay in bad workmanship during erection—in other words, the human element which he infers is only found in welding, is found in riveting also.

I can counter Mr. Milbourne's reference to a burst welded vessel by giving particulars of a riveted vessel which burst during caulking, under a pressure of only 30 lb. per sq. in. I am conscious of the failures of both types of vessels, also riveted and welded structures, due to the human element.

Mr. Milbourne states I now admit that I have some knowledge of only one riveted high-pressure holder which was not satisfactory. This statement is incorrect.

Welding technique has advanced so rapidly in recent years that I am emphatic in my opinion that the modern electrically welded seam in steel plates is considerably stronger, tighter, and more reliable than a riveted seam. Furthermore, welding is possible on very thick plates where riveting is impracticable.

Yours faithfully,

H. H. HOLLIS.

Oxley Engineering Company, Ltd.,
Clarence Road, Leeds, 10.
Sept. 2, 1946.

Production of Coke from ovens and gas retorts in Canada during April amounted to 282,825 tons compared with 338,285 tons produced in the previous month and 325,617 tons in April, 1945.

The Sports and Social organization of Messrs. J. H. Robinson & Co (Liverpool), Ltd., Gas Meter and Water Heater Manufacturers, held their outing on Saturday, Aug. 24, when approximately 250 members and friends left the factory in coaches and spent a most enjoyable half-day at Blackpool. This was the first post-war outing and all employees having served in H.M. Forces went as guests of the organization.

A **Holiday Camp** at Dover, under canvas, was organized recently by the North Middlesex Gas Company for its gas fitters' apprentices. This section of the Company has been much increased by heavy recruitment during the past few months. Increased attention to their social welfare, as well as the implementation of the " further education " clause of the Education Act, 1945, is part of the Company's post-war policy regarding these young newcomers to the Gas Industry.

A Floating Restaurant

Here is a floating restaurant recently launched and put to work. It is moored in the Menai Straits alongside Caernarvon Castle.

The vessel, " Lee Ho," is 60 ft. by 26 ft. and seats 50 persons. It was built by a local shipbuilder (next to the gas-works). Gas is used for cooking, fish frying, tea-making, and hot water. A flexible pipe carries gas to the vessel. The floating restaurant is proving quite a novelty to the visitors to Caernarvon.

Surgery at a Gas-Works

Our photograph is of the fully fitted surgery at the Liverpool Gas Company's works. It has been in operation for over a year. It is the Company's policy to take the strictest precautions to prevent accidents of any kind. Nevertheless, there are many minor accidents through unforeseen causes which require immediate treatment. At the Garston Gas-works, during the past year, 699 of these injuries have been recorded, while there were no less than 223 home accidents to employees which necessitated treatment at the gas-works surgery. Each accident, no matter how trivial, is carefully investigated and re-dressing is done by the sister in charge. All juveniles are periodically subjected to medical examination and a record of health is kept which is of material assistance to the visiting surgeon. A Safety Committee sits once a month and all employees freely use the surgery and often express their appreciation. The Company is well satisfied with the scheme, which has reduced the number of hours lost by preventing the spread of infection and by prompt treatment of injury.

The Illuminating Engineering Society has now reprinted the I.E.S. Code for the Lighting of Building Interiors. This Code was published in its original form in 1936 and has since been in great demand by all who are interested in the adequate lighting of homes, factories, offices, and public buildings. It will be recalled that the 1945 edition contained several important new features—namely, the provision of a scientific background on which values of illumination are based, the inclusion for the first time of information on natural lighting, and the introduction of clauses relating to quality of lighting (absence of glare, &c.). The new edition now available is essentially the same as the 1945 edition, embodying only minor alterations of layout. Copies may be obtained, price 1s. 6d., from the Illuminating Engineering Society, 32, Victoria Street, London, S.W.1.

Gas for New Towns

If the Abercrombie Plan for the creation of new towns in the Greater London area is implemented, the Watford and St. Albans Gas Company will be faced with the immense problem of providing gas for more than double the present population. It is estimated that over a million pounds will have to be spent on extensions during the next three years to meet this increased demand.

Giving an overall picture of the probable concurrent development of the area and the Company, the Company's *Co-Partner* says: The Greater London Plan is the most significant factor affecting the Company's growth. This plan has now been examined in detail by a Central Advisory Commitee on Regional Planning and the basic principle of the following Rings has been accepted by all concerned:—

(*a*) The Inner Urban Ring consisting of the fully built-up area adjoining the County of London, from which hundreds of thousands of people are to be moved.

(*b*) The Suburban Ring—from the Inner Urban Ring to a radius of approximately 12 miles from Charing Cross. This area is considered to be already built up to the limit prescribed by tolerable conditions.

(*c*) The Green Belt Ring—extending for a depth of about five miles beyond the Suburban Ring. In this area, which includes Abbots Langley, Bushey, Chorley Wood, Elstree and Boreham Wood, Kings Langley, Radlett, Rickmansworth, Moor Park, and Watford, only small increases on present-day population figures of existing towns are recommended.

(*d*) The Uuter Country Ring—extending from the Green Belt Ring to the boundary of the London Region. In this area, including Harpenden, Hatfield, Hemel Hempstead, Redbourn, St. Albans, Welwyn Garden City and Chesham, it is proposed to accommodate a large part of the population to be decentralized from the overcrowded Inner Urban Ring. The above basic principles are to be varied in practice in two instances, to the extent that a satellite town has been planned by the London County Council at Oxhey (within the Green Belt) with a population of 30,000, and it is proposed to permit the growth of the Elstree and Boreham Wood district to a population of 33,000, although this project is opposed by the Hertfordshire County Council. The idea of creating a new town at Redbourn has been abandoned but, as an alternative, Hemel Hempstead is to be extended to accommodate 60,000 people. A new town is to be created at Stevenage and about one-third of the population will be within the Company's area of supply. The increase on 1938 populations affecting the Company are as follows:—

Place	Estimated population within built-up area in 1938	Ultimate population
Green Belt Ring—		
Abbots Langley	4,000	6,500
Bushey	8,500	15,500
Chorley Wood	3,000	8,000
Elstree and Boreham Wood	6,000	33,000
Kings Langley	2,750	6,000
Radlett	4,500	11,000
Rickmansworth	14,750	22,000
Watford	69,000	79,000
Moor Park	2,250	2,750
Oxhey (satellite town)	—	30,000
Outer Country Ring—		
Harpenden	12,000	20,000
Hatfield	9,750	25,000
Hemel Hempstead	17,000	60,000
Redbourn	2,500	5,000
St. Albans	33,250	60,000
Welwyn Garden City	13,500	36,500
Stevenage (part)	1,000	20,000
Chesham	9,250	13,000
	213,000	453,250

It will be seen that the result of these proposed increases is that the population in the Company's area will, in the future, be 240,000 greater than in 1938, and it is an accepted principle of the Plan that sufficient industry shall be developed in each town to support its own population.

All these extra inhabitants require gas and, to meet this demand, there will have to be a very large and rapid increase in the capacity of the Company's carbonizing plant and all its ancillaries. To meet the anticipated load, work is already in progress on a three million cu.ft. per day continuous vertical installation at St. Albans, to be brought into operation early in 1947. For the same works a second three million cu.ft. per day carburetted water gas plant has been authorized, and the existing vertical chamber installation is to be reconstructed and enlarged to a gas-making capacity of four million cu.ft. a day. At Watford Works the No. 1 retort house will be rebuilt and the purification plant will be expanded at all manufacturing stations. Within the next three years the weekly manufacturing capacity of the plant is to be increased from 88 million cu.ft. to 110 million cu.ft. with an adequate reserve, and additional storage capacity will be installed throughout the area of supply.

The capital expenditure involved during the next three years, as already submitted by the Company to the Ministry of Fuel and Power, amounts to over a million pounds, a third of which is required for additional mains and distribution works.

Under present circumstances it is impossible not to mention nationalization but it is obvious that the demand for the Company's products will increase enormously.

Homes of To-morrow

A new exhibition, sponsored by the *Yorkshire Evening News*, which deals with all the requirements of the modern home, was opened at Lewis's Stores, Leeds, on Aug. 30. It was opened by Mr. L. Silkin, Minister of Town and Country Planning, who paid tribute to the Leeds City Council, who had been pioneers in housing activity. Speaking of the housing problems now facing the country, he warned that the mistake made in the past of allowing jerry-built houses to go up without the supervision necessary for health and comfort must not be repeated. Only the best possible houses would suffice, and there must be in those houses all that was latest and best in devices and designs which would ease the lot of the people living in them. For that reason particularly, Mr. Silkin said he welcomed the participation in the exhibition of the firms who had devised various types of equipment.

The exhibition is the biggest of its kind to be held in this country since before the war and shows the latest products affecting every aspect of home life. A prominent feature is the number of kitchens designed for several types of houses; the small flat, the converted house, and the medium-sized family house in town or country. Those arranged by the British Gas Council are remarkable in that every unit and appliance is in production and available for the houses built by local authorities under the Government schemes. All the kitchens are made up of standard units and, as a result of the work of the British Standard Institution, attractive combinations of these units may be grouped together in various ways to suit any size kitchen. Old-fashioned kitchens may be modernized and improved by the use of standard cupboards and built-in equipment, thus making the most of limited or inconvenient space.

A prefabricated kitchen, based on Government-inspired plans, demonstrates the possibilities of these prefabricated units and includes a built-in gas cooker with oven heat control, a gas refrigerator also built-in at a convenient height, a gas water-heater for summer use, and a gas wash-boiler which can be stored under the draining board when not in use. Special features are the smooth, uniform working surfaces; the hot and cold water pipes, waste pipes, and service pipes concealed in the middle of the unit; and the cheerful colour schemes.

Another kitchen is a replica of those designed for the Ministry of Works demonstration houses at Northolt and is unique in the provision of a dinning annexe; a help to the mother with young children. A coke boiler is equipped with a gas poker and has above it a gas circulator for summer use. The gas cooker is of the horizontal type with the hotplate level with the top of the oven. An instantaneous water heater over the sink, a gas copper to which a wringer can be attached and which can be stored in a cupboard under one of the draining boards, and a draw-leaf table are also featured.

A third kitchen is planned round one of the Ministry of Works' prefabricated units. This unit extends to the height of the house and consists of a gas-ignited coke fire in the living room with a back boiler to heat the 30-gal. water tank serving bath, basin, sink, towel-rail, and drying cupboard. A gas circulator for the summer is fitted to the tank and the drying cupboard may also be heated by gas when the coke fire is not used. Warm air ducts to the dinning annexe and two bedrooms are an unusual feature.

A kitchen and bathroom unit contains a plastic and aluminium sink which is fitted with gas burners so that it may be used as a wash-boiler. The sink itself is of stainless steel, insulated along the front edge, and the draining boards are of aluminium. A wall recess behind one draining board housing a wringer is covered by the sink lid. Gas appliances are, of course, installed in both kitchen and bathroom.

A novel feature is the water heating display which demonstrates how gas can solve domestic hot water problems. A recorded commentary by Frederick Grisewood may be operated by a press button.

In the lecture hall, talks to visitors by such experts as Professor A. M. Low are to be heard.

Oldham Gas Committee has accepted a tender amounting to £16,250 (plus 10% for contingencies) for the rebuilding in the summer of 1948 of 64 retorts at Hollinwood Gas-works.

Linlithgow Gas Company has secured the contract for the supply of gas to the new cooking depot for schools at Linlithgowbridge. To meet this demand, the Company may require additional storage accommodation.

Newton-on-Ayr Gas Company has announced that owing to the increased cost of material and manufacture, the Ministry of Fuel and Power has authorized an increase of 8d. per 1,000 cu.ft. in the price of gas.

Publication of the latest edition of "List of Plants Installed" has now been announced by Whessoe, Limited. The previous edition of this leaflet was issued just before the war, when details were given of 40 W.W.-D. electroc-detarrer plants. The present edition shows summarized particulars of 126 plants. Since the date of going to press with this list it is interesting to record that another 14 plants have been ordered, making the present total 140 W.W.-D. electro-detarrers in operation or under construction. Copies will be distributed as soon as possible and are also available on application.

Preparation of Coke

Discussion on the Paper by P. C. Gardiner, F.R.I.C., M.I.Chem.E., Chief Chemist, Tottenham and District Gas Company, at the Annual Meeting of the Institution of Gas Engineers. The Paper was published in abstract in the "Journal" of Aug. 21 (page 312) and Aug. 28 (page 360). The first part of the discussion was published in our issue of Sept. 4.

Mr. P. C. **Gardiner** continued :—I am in complete agreement with Mr. T. F. E. Rhead as to the advisability of reducing the dust in gas-works and the coke screening plant is, of course, the great offender. The practicability of the suggestion he makes I must leave to the engineers but his object would in large measure be attained by dedusting the coal before carbonization. This would substantially reduce the trouble arising on the coke screening plant and in this connexion, attention is directed to Table 5, which shows the proportion of breeze in coke from "clean" coal is only half that from the original slack.

If I understand Dr. G. E. Foxwell correctly, he doubted whether it was possible to produce coke really suitable for use in existing grates which are sometimes unsatisfactory even for burning coal. It is agreed that some old coal burning grates are worse than useless and this is why in the course of my introduction mention was made of the late Professor Boys' view that coke should burn satisfactorily without a grate at all. Moreover, with coke produced as recommended this is quite possible, and in fact is practised in my office regularly throughout the winter.

Replying further to the question of suitability, coke similar to that of which tests are given in Table X has been continuously supplied from the Tottenham Gas-works since 1928. It has been in use in all sorts of grates with satisfactory results and this is borne out by the rapidity with which the sales increased, namely, from 2,700 tons in the year 1928 to 14,000 tons in 1939. Since the commencement of the war it has been impossible to cope with the demand; but in spite of difficulties at the works the sale of open fire coke has been maintained at approximately 12,000 tons per year.

In putting this question Dr. Foxwell has confirmed my suggestion that long experience with unreactive cokes has tended to blind both coke producers and consumers to the advantages inherent in light bulk density cokes.

Economics are not worked out in the Paper, but they were certainly not ignored, since emphasis is placed all the time on the conflict of interests between gas and coke manufacture.

An Impartial Study

It may well be that in order to gain the smokeless fuel market, the Gas Industry will have to re-orientate its working more strictly on the lines of a two-fuel industry, acknowledging equal claims for gas and coke. In my view it would be in the interests of both the gas undertaking and the consumer if an impartial study of the opposing interests were made side by side with an investigation into the economics of clean coal.

Dr. Foxwell's example of coal cleaning is an unfortunate one as the amount of cleaned coal produced was only 60%, whereas in the case of the coal with which the Tottenham experiments were conducted, 80% of the original coal was used for gas making and ash contents was of the order of only 2%.

Mr. Morland Fox referred to bulk density and doubted whether coke occupying 100 cu.ft. per ton could be described as ideal and he drew attention to the fact that an exception was referred to in the text of the Paper. In spite of this one exception, I still consider from a general standpoint coke occupying 100 cu.ft. per ton is to be preferred to the heavier varieties.

Mr. Morland Fox also pointed out that coke from the softer coal usually contained a higher proportion of breeze. To a large extent this depends upon the ash contents of the coal as carbonized, a fact which often goes unnoticed. I would, therefore, refer Mr. Morland Fox to Table 5, the figures of which indicate how the breeze production is reduced to half by cleaning the coal down to its inherent ash.

It is agreed however that run of retort coke from low rank coals generally contains more breeze than the denser cokes. Against this the lighter cokes require less cutting to make them suitable for open fires, and this is of great advantage in reducing breeze production. With denser cokes No. 2 is essential for open fires, but in the case of soft cokes from Derbyshire and Nottinghamshire coals, the large coke as well as No. 2 size can be used quite satisfactorily, and a blend of the two is excellent.

In reply to Mr. C. H. Bamber, I do not wish to perpetuate the use of old-fashioned coal grates longer than is necessary. My point is that it is completely impracticable to replace the ten millions of coal grates at present in use for many years to come, and that in the meantime I conceive it the duty of gas-works to produce a quality of coke suitable for use in these appliances, and by the method outlined, this can be done.

I accept the criticism that owing to the lightness of such cokes, the fire requires more frequent attention to keep it alight. On balance, however, I am convinced that benefits to be derived from coke occupying 100 cu.ft. per ton more than offset the advantages of denser coke of 70 cu.ft. per ton to which both Mr. Bamber and Mr. Morland Fox referred.

In my opinion, this problem is emphasized in the case of a small domestic boiler, which was, however, not referred to specifically. Here the quantity of fuel is necessarily restricted to the volume of the fuel bed and this limits the period during which the fire can be kept alight without attention. Even in this case it is still contended that the coke of higher reactivity is to be preferred and this has been demonstrated repeatedly by tests on the boiler of the smallest accepted size. The point here is that the higher reactivity of the coke enables the fire to be kept alight by a smaller quantity of air per hour, and in consequence, the rate of consumption of fuel will be less. Incidentally the C.A.B. test affords a useful gauge of the reactivity in such cases and in my judgment this is the main use of the test.

I am very pleased to learn of Mr. Bamber's method of producing reactive coke from high rank coal and shall be most interested in subsequent developments; but the process referred to would appear to be quite a special one and its success on the scale mentioned in no way affects my general statement at present.

I should like to thank Mr. G. E. Currier for the support given in several items in the Paper and also for figures he was good enough to give on coal cleaning and the ash contents of coke and breeze. These provided the confirmation I was lacking, particularly concerning the relatively low ash content of the smallest breeze.

I am very pleased to learn from Mr. L. G. Townsend the procedure adopted at Liverpool, particularly as it would appear to be substantially in accordance with the recommendations in the Paper, both with regard to the effect of the origin of coal on coke quality and the possibilities of the disposal of breeze by blending.

His opinion on the question of activating Durham coke is also interesting in view of the experience gained at Liverpool with this method of treatment of other coals.

In thanking Dr. J. G. King for his generous remarks, I would like to emphasize the value of the inclusion in the Gas Research Board's programme of the promised investigation into coke cutting and the incidence of breeze production as well as the study of the effects of cleaning coal down to its inherent ash. In connexion with the latter work, I sincerely hope that it will be possible to include a comparison of the cokes from high and low rank coals.

I regret that when referring to the researches of Marson and Cobb in 1925 which lead up to activation of coke, I was unaware of the earlier work carried out by Dr. R. Lessing on the same theme. In his remarks, Dr. Lessing gave some details of his coal cleaning process and I would call particular attention to the importance of dedusting the coal before the separation of the ash by the flotation method.

Mr. H. H. Thomas has raised the question of the critical air blast test and from his contribution it would appear that he prefers to rely upon the results of this test as a gauge for open fire coke rather than upon the bulk density, but on this point my experience does not support his view.

Observations over a number of years have confirmed the correlation between light bulk density and reactivity in coke. Such treatment as long continued heating in a vertical retort must be regarded as exceptional.

In my opinion, the C.A.B. test is useful only as a gauge of what may be termed basic reactivity. In the performance of the test a number of factors important in the coke fire, such as sizing, grading, pore structure and moisture content are eliminated, and thus the usefulness of the test as a gauge of open fire coke is destroyed except so far as the major and usually obvious differences between fuels are concerned.

In support of this contention I give the results of some critical air blast tests carried out some years ago on Yorkshire and Durham coals in continuous vertical retorts and in intermittent vertical chambers.

CONTINUOUS VERTICAL COKES

Coke used	C.A.B. cu.ft. per min.	Gas for ignition	Dry coke burnt	Cinders left in grate
100% Yorks coal H. ...	0.046	12.0 cu.ft.	2.40 lb./hr.	1.25 lb.
Mixed Yorks coal ...	0.053	14.0 „	2.24 „	1.83 „
70% Yorks coal H. ...	0.055	12.0 „	2.31 „	2.0 „
84% Yorks coal H. ...	0.056	Very satisfactory fuel in open fire.		

INTERMITTENT VERTICAL COKES

Coke used	C.A.B. cu.ft. per min.	Gas for ignition	Dry coke burnt	Cinders left in grate
100% Yorks coal H. ...	0.058	15.0 cu.ft.	2.37 lb./hr.	2.1 lb.
Mixed Durham and Yorks coal ...	0.058	23.0 „	1.93 „	2.5 „
100% Durham coal ...	0.058	25.0 „	1.89 „	2.7 „
Mixed Durham and Yorks coal ...	0.058	20.0 „	1.81 „	2.6 „

In the above table the figures for gas for ignition, rate of coke burning and weight of cinders left in grate, are given to indicate the relative suitability of different cokes for open fire work. Referring first to the intermittent coke, it will be observed that there was obviously a substantial difference in both ignitability and burning between the coke produced from 100% Yorkshire coal and the others, as indeed one would expect; but reference to the C.A.B. determinations in the case of these cokes shows that the figure was precisely the same in each case, and I should add that these tests were done under the strictest possible laboratory conditions.

Reference to the tests of continuous vertical cokes shows that except perhaps for the first test, the C.A.B. results are very little different from those on the intermittent vertical chamber coke in spite of the fact that the continuous vertical cokes were superior, in practice, as open fire fuels.

May I conclude by saying that the comment made during the course of the discussion that I am largely preaching to the converted is accepted; but my desire is to emphasize that coke of much more acceptable quality can be produced without any fundamental alteration in gas-works practice; and, in my opinion, the reason why it is not done more often is due to adverse economic conditions.

The obvious line of approach to any adjustment of gas-works economics is by recognizing that gas and coke have equal claims to consideration. This should lead to the treatment of the carbonization of coal as a two-fuel industry, and I trust that efforts will be made to investigate this aspect thoroughly in the mutual interests of gas undertakings and national fuel economy.

Separation and Chemical Utilization of Coal Gas Constituents*

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IT is anticipated that in Great Britain during the next few years there will be a considerable extension of the manufacture of materials such as plactics, synthetic rubber, solvents, refrigerants, anæsthetics, fine chemicals and a wide range of other materials. The substances required as the basis for these synthetic materials are, for the greater part, simple chemical compounds which must be obtained from either coal or petroleum.

Some of the constituents of coal gas, such as ethylene and propylene, are of great importance in this connexion, while recent researches show that others, such as methane and carbon monoxide, may be almost equally valuable in the future. While it is too early to make more than tentative suggestions as to what part the Gas Industry might play in providing raw materials for these new processes, it is considered that the Industry should be acquainted with the general aspects of the subject.

The first requirement is to separate the desired constituents from the other substances present in coal gas. While liquefaction and low-temperature fractionation are the more likely methods of separating coal gas, diffusion and adsorption cannot be neglected.

It is considered doubtful whether hydrogen alone could normally be separated from coal gas at a competitive price, but, if other constituents were being separated as well, then use might be made of the hydrogen. The only established source of large quantities of methane in this country is in the gaseous products of carbonization. Methane is less reactive than ethylene, but is present in coal gas to a greater extent and might be made in large quantities by complete gasification processes.

At present ethylene is the most valuable constituent of coal gas for chemical syntheses on account of its simplicity and reactivity. The utilization of ethylene has been explored widely, and processes for making 50 different chemicals from ethylene have been taken to the stage at which commercial manufacture could be undertaken, provided that the market demand were adequate. In addition, there are many other processes which might be developed. Propylene is present in coal gas to a smaller extent than is ethylene, but could be separated simultaneously. It is particularly useful in chemical syntheses because it contains 3 carbon atoms and can readily be made to provide valuable compounds containing this number of atoms in the molecule.

Lack of Statistics

It would have been useful to have been able to provide some idea of the present, or immediate pre-war, British production of some of the more important substances referred to, and to have included a table of their market values. Such figures are available, however, only in a few cases. More frequently, United States production and cost figures are available, and some are quoted: American cost figures may, however, bear little relation to British conditions. Where it has been possible to suggest a cost for a particular process or product, this has only been done in order to show that the process is not unworthy of consideration on these grounds.

Coal gas† is a mixture of several constituents, most of which can be made use of in one or another of the newer chemical syntheses. It might be possible, in a carefully integrated scheme, to make use of the bulk of the materials which could be separated from a given quantity of coal gas. It is the object of this Paper to review the methods by which the constituents of coal gas can be separated, and to give a brief account of the major uses to which these constituents might be put.

In the immediate future the most valuable constituent of coal gas is likely to be ethylene, which is present in carbonization gases to the extent of 1 to 2%. This is equivalent to a total amount of ethylene in the carbonization gases produced of about 360,000 tons per annum. It is probable that if ethylene were separated, propylene also would be obtained. The percentage of propylene in coal gas is not generally known with any accuracy, but is of the order of 0.2 to 0.5% by volume. The total quantity present in the gas produced in the carbonization industries is, therefore, of the order of 100,000 tons per annum. Approximately half the quantities of ethylene and propylene referred to are present in the gas produced by the Gas Industry, and the other half in that produced by the coke oven industry.

It is possible to separate methane and use it as a raw material in a number of chemical processes. The amount of methane made in this country during carbonization amounts to about 2.5 mill. tons per annum, of which about half is made by the Gas Industry. If only a small proportion of this were available for use as a raw material, a considerable chemical industry could be supplied. At the same time higher paraffinic hydrocarbons would be separated and could be made use of.

Hydrogen is the constituent of coal gas present in the greatest proportion by volume, but on account of its low specific gravity the total amount present is equivalent only to about 900,000 tons per annum. This could be separated and used in the manufacture of synthetic ammonia or in hydrogenation processes. It is doubtful, however, whether it would be economic at the present time to separate only hydrogen from town gas. On the other hand, in a carefully integrated scheme, the prices commanded by other constituents separated from town gas, such as ethylene and propylene, might be such as to enable the hydrogen to be sold at a competitive price.

Another constituent of coal gas which might possibly be made use of is carbon monoxide. Phosgene, a useful chemical intermediate, can be made by passing carbon monoxide and chlorine over active charcoal catalyst at 100° to 125° C. Another type of reaction investigated in recent years is the direct addition of carbon monoxide to organic compounds under pressure, to give oxygenated products; *e.g.*, it combines directly with methyl alcohol at 200 atm. pressure and a temperature rising from 30° to 110° C., using sodium methylate as a catalyst. The product passes through further chemical changes to produce acrylonitrile.

* From Communication No. 294 of the Institution of Gas Engineers.

† In this Paper the term "coal gas" is used in a wide sense to include any gas normally sold as town gas; also coke oven gas.

Separation of Gases

The methods by which mixtures of gases can be separated have received inadequate attention in this country, particularly on anything larger than laboratory scale, except in the case of the separation of air. The main methods suggested by fundamental science include adsorption, solvent extraction, chemical extraction, liquefaction, or diffusion. Of these processes, liquefaction is the one which has found most general application.

Removal by chemical extraction is only applicable in the case of reactive gases, such as ethylene or propylene. In these cases, for example, removal could be brought about by the use of either sulphuric acid or hypochlorous acid, but these processes are rather slow and require bulky absorption plant and recovery units.

The concentration of, for example, ethylene and propylene by physical processes such as solvent extraction or adsorption on a solid such as charcoal, requires further experimental examination.

Recently a new method of removing ethylene and propylene from coke oven gas has been developed in the United States. This is known as the Hypersorption process, and consists in passing the gas through a bed of active charcoal moving counter-current to the gas stream. The process operates at room temperature and pressures up to about 3 atm. The olefines are displaced from the charcoal by steaming.

Diffusion

There are two ways in which the process of diffusion might be used to separate a mixture of gases, and these may be referred to as gas diffusion and thermal diffusion. The former depends on the fact that lighter gas molecules travel at a greater speed than heavier molecules, with the consequence that a relatively greater proportion of lighter molecules will pass through a porous membrane in a given time. The rate of diffusion S is related to the partial pressure p of a constituent of a gas mixture whose density is d by the equation

$$S \propto \sqrt{\frac{p}{d}}$$

Consequently, the process is particularly suitable, in the case of coal gas, for separation of hydrogen which has a high partial pressure and low density and will therefore diffuse readily.

It can be calculated that if coal gas were allowed to diffuse through a suitable membrane until about half of the hydrogen has passed through, the percentage of hydrogen in the gas which had passed the membrane would be about 70% instead of 50%. It is evident that in order to achieve effective separation of the constituents of coal gas, a considerable number of stages would be needed, and that this would entail erection of considerable plant.

That it is technically possible to make use of this process is shown by the fact that it was used at Oak Ridge, U.S.A., in order to separate the hexafluoride of uranium 235 from those of the other uranium isotopes, for use in atomic bombs. Many engineering problems, such as construction of membranes on a large scale, evidently have been solved. Although details of the plant required, and its performance, have not been published, there is no doubt that the separation of these isotopes is particularly difficult on account of the small difference (0.85%) in density between the different isotopic forms, as well as the highly reactive chemical nature of the gases. Consequently, there should be no technical difficulty in effecting separation of at least some of the constituents of coal gas. It is not possible, with the information at present available, to calculate the size of plant required for a given separation, nor to provide any idea of what costs might be entailed. Considerable interest attaches to the publication of actual performance figures and results of the Oak Ridge plant.

S. Chapman, in 1916, showed by a theoretical treatment of mixed gases that if a thermal gradient be set up, the heavier molecules will concentrate in the cooler region and the lighter ones in the warmer region. This process is known as thermal diffusion and has been used to separate isotopes. For example, in one application of this method, K. Clüsius and G. Dickel have used an apparatus in which the walls are vertical and the hot surface is an electrically heated wire. In addition to thermal diffusion taking place horizontally between the hot wire and the cool walls, there is a thermosiphoning action, causing the gas near the hot wall to rise and that near the cooler wall to fall. In this way the lighter ingredient collects at the top of the tube and the heavier at the base.

More recent application has been in the separation of the isotopes of uranium, using the hexafluoride. It is not quite clear whether the separation took place in the gaseous or liquid state in the full-scale plant, but it is known that a pilot plant was in operation, in which the separation took place in the liquid phase.

Liquefaction

In recent years there has been a considerable increase in knowledge of liquefaction processes and experience in the technique of large-scale liquefaction, but this has been more evident in Russia, Germany, and the United States than in England. In the case of the separation of individual components from a gaseous mixture, it is essential to know the phase equilibria under different conditions of temperature and pressure; that is to say, it is necessary to know the relative compositions of the vapour and liquid phases when equilibrium has been reached under any particular conditions of temperature and pressure. Knowledge of heat transfer and thermal insulation at low temperatures is also required, and one of the important practical aspects in constructing a liquefaction plant is the design and method of fabrication of the heat interchangers.

In considering the type of liquefaction process to be adopted in the separation of the constituents of coal gas, a great deal depends on which constituents it is desired to separate. For example, if it be desired to separate only hydrogen, then the most economic method is likely to be the Linde-Bronn process, which has been widely used on the Continent. Normally, the hydrogen is used for manufacture of synthetic ammonia, for which nitrogen is required as well as hydrogen separated from coke oven gas. The gas is freed from carbon dioxide, hydrogen sulphide, benzene and water, and at 12 atm. pressure is partially cooled by a subsidiary ammonia cycle. Air is liquefied and separated by the Linde process so as to produce a nitrogen fraction as pure as possible. The refrigerating power of the cold fractions from the air separation plant is used to cool the coke oven gas. The condensation products from the latter are separated in three fractions, the first being known as the ethylene fraction, the second as the methane fraction, and the third, which results from scrubbing out the remaining carbon monoxide from the residual hydrogen gas by means of liquid nitrogen, is known as the carbon monoxide fraction. The composition of the three fractions is shown in Table 1:

TABLE 1.—*Volume and Composition of Fractions (Linde-Bronn Process)*

	Original Gas	Ethylene Fraction	Methane Fraction	Carbon Monoxide Fraction	Synthesis Gas Fraction
Composition (Per Cent. by Vol.)					
H_2S	1.0	—	—	—	—
CO_2	2.2	—	—	—	—
C_2H_4	2.9	44.5	0.2	—	—
C_nH_m	0.4	5.6			
O_2	0.2	0.7	1.7	2.0	—
CO	7.6	0.3	14.5	27.5	—
H_2	52.5	1.9	3.8	3.0	75.0
CH_4	27.0	23.2	70.4	2.4	—
C_nH_m	2.0	21.0	2.1	—	—
N_2	4.2	2.3	7.1	65.1	25.0
Volume (cu.ft., Dry at N.T.P.)	1,000	57.8	351.8	83.1	662.1
Gross Calorific Value (B.Th.U. per cu.ft.)	556	1,424	799	120	240

In the Linde-Bronn process, all liquid products are evaporated and their temperature is brought back to approximately atmospheric by interchange with incoming gas. In this way the whole process is balanced so as to give hydrogen and nitrogen in the ratio of 3 : 1 by volume for the synthesis of ammonia. If it were desired to remove either or both of the ethylene and the methane fractions in the liquid state for further pruification, *e.g.*, fractionation, prior to use as raw materials for chemical processes, the thermal balance of the Linde-Bronn process would be upset. Cooling of the coke oven gas could then only be effected by producing more liquid air than is required for the synthesis of ammonia. On the other hand, if the ethylene and methane fractions were found to be sufficiently pure for subsequent chemical treatment without fractionation, the gases could be withdrawn after being warmed to room temperature. In any case it should be pointed out that it is desirable to link a process such as the one described with some process which will make use of the oxygen separated from the liquid air. This might, for example, be a complete gasification process.

If the process of isolating the ethylene and methane fractions were not linked with another process, such as synthesis of ammonia, or gasification of coal, it would probably be more economic to use a different type of liquefaction process. For example, A. C. Egerton, T. A. Hall and M. Pearce have recently discussed a possible scheme for separating an ethylene fraction and a proportion of the methane in coal gas. The object of their scheme is to separate during the summer months about one-third of the methane, for storage in liquid form against peak load requirements in the winter months. The system they propose is to compress the whole of the gas to 3 or 4 atm. (absolute), at which pressure the gas would be treated for removal of constituents such as carbon dioxide, water vapour, benzole, &c. This

purification could be effected by cooling, or by chemical or physical absorption by liquids or solids. The gas, after purification, would be cooled, first by exchange with warming fractions and then by liquid methane, which might come either from storage or from an auxiliary cycle. By cooling as far as the boiling-point of liquid methane (−161.5° C.) the whole of the ethylene would be condensed, a laboratory result for a typical coal gas being shown in Table 2:

TABLE 2.—*Volume and Composition of Fractions (Ethylene Separation)*

Composition (per cent. by Vol.)	Original Gas	Condensate	Residual Vapour
C_nH_m	3.3	47.8	—
O_2	0.6	0.7	0.6
CO	12.2	3.0	12.9
H_2	50.5	—	54.1
CH_4	21.0	23.8	20.8
C_2H_4	1.1	16.5	—
N_2	11.3	8.2	11.6
Volume (cu.ft.)	1,000	67	933
Gross Calorific Value (B.Th.U. per cu.ft.)	504	1,625	421

The ethylene fraction would be expanded to 1 atm. pressure, as a result of which the nitrogen and carbon monoxide in it would evaporate, leaving a liquid even richer in hydrocarbons. If it were desired to liquefy a proportion of the methane, about 40% of the uncondensed gas would be further compressed to 13 atm., which calculation shows to be the pressure at which the work required to liquefy a given quantity of gas is a minimum. At 13 atm. pressure and −161.5° C. a liquid of the estimated composition, 13% carbon monoxide, 74% methane, 13% nitrogen, would be separated. After expansion of this condensate to 1 atm. the carbon monoxide and nitrogen would largely evaporate, but only about 15% of the condensed methane. The uncondensed gas would be expanded in a turbine to recover some of the work of compression and it would be passed through heat interchangers to recover as much refrigeration as possible.

The effect of removing the olefines from coal gas would be to reduce the calorific value per cu.ft. of gas sold by 8 to 12%, and the effect of removing the olefines and one-third of the methane would be to reduce it by 17 to 21%. It should be noted, however, that thermal yield per ton of coal would be reduced by a greater amount; *i.e.*, 10 to 15 and 24 to 30%, respectively.

German Processes

Information has recently been disclosed of a number of liquefaction processes in use in Germany during the war. In one of these, at Hoechst, stripped coke oven gas from the Ruhr is separated into a methane fraction, a hydrogen fraction and residual gas. About 250,000 cu.ft. of gas are separated per hr. The gas is first compressed to 15 atm. and is washed with water and caustic soda to remove carbon dioxide. It is then cooled to −30° C. by interchange with gas leaving the fractionation plant, and to −45° C. by an ammonia cooler. The remainder of the cooling is carried out with the aid of liquid nitrogen from a Linde plant, boiling under reduced pressure if necessary. The composition and relative quantities of the fractions are shown in Table 3:

TABLE 3.—*Volume and Composition of Fractions (Hoechst Separation)*

Composition (per cent. by Vol.)	Original Gas	Methane Fraction	Hydrogen Fraction	Residual Gas
CO_2	2.5	—	—	—
C_nH_m	0.4	—	—	—
C_2H_4	2.4	0.6	—	9.0
O_2	0.5	—	—	0.5
CO	6.5	0.2	0.5	28.0
H_2	54.6	—	98.5	5.5
CH_4	24.0	98.4	—	18.5
C_2H_6	1.3	0.4	—	5.5
N_2	7.8	0.4	1.0	33.0
Volume (cu.ft.)	1,000	195	525	280

The second German plant examined was at Castrop-Rauxel, and had as its main object separation of the constituents of coke oven gas in order to provide hydrogen for the manufacture of synthetic ammonia. Ethylene was also recovered and purified. The plant consisted of four Claude units, each capable of dealing with 280,000 cu.ft. per hr., and one Messer unit capable of dealing with about 350,000 cu.ft. per hr. The latter is very similar to the standard Linde-Bronn unit. The Claude unit operates in the following way:—The coke oven gas is compressed to 25 atm. and washed with water and then with a 3% solution of ammonia to remove carbon dioxide and hydrogen sulphide. The gas is then cooled in three towers, an ethylene-rich fraction (35% ethylene, 15% ethane, 50% methane) being separated in the first; and a methane-rich fraction in the second. In the third, liquid nitrogen from a neighbouring plant is used to wash out the residual carbon monoxide, as in the Linde-Bronn process. The residual gaseous hydrogen is expanded through a reciprocating engine lubricated with liquid nitrogen, and is thereby cooled to a much lower temperature. This gas as well as the vaporized and expanded liquid cuts serves as cooling agent for the process.

The Claude unit is said to be less costly than the Messer unit, but power consumption in both cases is the same, *i.e.*, about 8.5 kWh. per 1,000 cu.ft. of coke oven gas.

At the present stage in the development of liquefaction processes designed to separate ethylene and methane from coal gas, calculations of costs in this country are speculative. It is interesting to record, however, that the cost of liquefying natural gas by the cascade process in Cleveland was quoted as being less than 1 cent per lb. in 1942; while in Holland, during the war, the cost of producing liquid methane from coke oven gas was said to be 0.6 of the cost of the same volume of petrol. The greatest factor in reducing the cost of separation of coal gas constituents by liquefaction will be the arrangement of a carefully integrated scheme using all the products of the various processes involved to the best advantage. If this were done, it is conceivable that methane and ethylene would be available at less than 2d. per lb., assuming 1938 figures; or 3d. per lb. to-day. In calculating these figures it has been assumed that the value of methane and ethylene is the same as that of the other constituents of coal gas on a calorific value basis.

Hydrogen

Hydrogen is a most important gas for many chemical processes, mostly coming under the heading of hydrogenation processes. One long-established application is the hydrogenation of unsaturated organic compounds in the liquid phase; the catalyst used is normally nickel supported on kieselguhr or charcoal. The chief application of this process is in the "hardening" or partial saturation of natural fats. This is carried out at a temperature of the order of 170° to 190° C. and at pressures up to 5 atm. As an example of the scale of this industry, in 1937 world production of hydrogenated fats was between 500,000 and 600,000 tons.

Other examples of hydrogenation in the liquid phase are the hydrogenation of naphthalene, phenols and cresols to give hydroaromatic compounds of value in the paint and soap industries, and as solvents. This type of process is also used for production of certain fine chemicals and perfumes, such as menthol, isopropyl alcohol, &c. More recent developments in hydrogenation have been the conversion of coal and tar to oils which could be used as petroleum substitutes. This has been more extensively applied in Germany than in this country. Hydrogenation is made use of in refining petroleum oils in the United States.

In the Fischer-Tropsch synthesis of hydrocarbons the raw material must be a gas containing carbon monoxide and hydrogen, usually in the ratio of 1 : 2 by volume. Clearly this gaseous mixture could be made by addition of hydrogen to blue water gas. Other uses to which hydrogen can be put industrially include the synthesis of ammonia, to which reference has already been made.

It will be seen that very considerable quantities of hydrogen are required for various purposes. Requirements in this country are not known, but probably amount to only a fraction of the hydrogen present in coal gas. There is a variety of methods by which hydrogen can be manufactured, the process selected depending on local circumstances. One of the more common processes is the reaction between steam and iron, followed by a reduction of the iron oxide by blue water gas. The best known modifications of this process are associated with the names of Lane, Messerschmidt and Bamag.

Another common process is to cause blue water gas to react with steam over a suitable catalyst whereby the carbon monoxide is converted to carbon dioxide, and the steam reduced to hydrogen by the water gas shift reaction:

$$CO + H_2O \rightleftharpoons CO_2 + H_2$$

In this case it is necessary to remove the carbon dioxide; *e.g.*, by washing with water under pressure. Other processes which may be made use of include electrolysis of water; and if natural gas or hydrocarbons are available, pyrolysis, or treatment with steam at 750° to 1,000° C. according to the equation

$$CH_4 + 2H_2O = CO_2 + 4H_2$$

As far as economics are concerned, it is doubtful whether hydrogen alone could normally be separated from coal gas at a competitive price. If, however, ethylene and methane were being separated, and commanded a higher price than they would as fuels, then the hydrogen might be disposed of at a price attractive to both producer and consumer.

Methane

During the war the necessity for using indigenous fuel supplies to best advantage, and the danger of grave shortage of petroleum fuels for civilian purposes, caused attention to be paid to supplies of methane which occur naturally in this country, or which are produced during sewage disposal. Clearly, if methane from such sources is sufficiently assured in quantity, then it could be made use of for chemical treatment. Optimistic estimates have been made by a number of writers, but further examination of the possibilities does not confirm them.

Considerable quantities of methane escape from almost all coal seams as fire damp, which may contain up to 98% of methane, the remainder being nitrogen and carbon dioxide. Samples of coal taken from various seams in different coalfields in this country have frequently given figures of the order of 200 cu.ft. of methane per ton of coal, although quantities as high as 5,000 cu.ft. per ton have been reported. It has, therefore, seemed an attractive idea that methane should be withdrawn before coal is worked, so reducing ventilation costs and obtaining a valuable commodity. Unfortunately, however, when borings are made into coal seams or surrounding strata, methane is only occasionally produced in appreciable quantities, and there is no known correlation between the geological or chemical nature of the strata and the appearance of methane. It has recently been reported that, in West Virginia, horizontal drillings have been made at depths of 100 to 1,000 ft. into coal seams, and methane withdrawn by exhausters. As British coals are in general not very permeable to gases, it seems doubtful whether this method could be successfully applied in this country.

The presence of gas in borings made for oil in this country is equally unpredictable, and when gas is liberated in such borings, neither the life nor the rate of decline of the supply can be forecast with any accuracy. It is impossible, therefore, for any use, which requires continuity of supply over a long period, to be made of this gas.

A gas containing about 70% of methane and 30% of carbon dioxide is liberated during the anaerobic fermentation of sewage sludge which is employed at many sewage disposal works. The amount of gas which can be collected amounts to between 0.6 and 1.0 cu.ft. per day per head of the population in the area draining to the works. At present about 5 mill. cu.ft. are collected per day, but the gas is mostly used for power production at the various works. The quantity might be increased to a certain extent without much difficulty and expense, and it would be economical to collect considerably greater quantities if sewage works were centralized. Centralization is, however, a major engineering undertaking which requires great capital expenditure.

There are a number of minor sources of methane in this country which would become major supplies if the processes involved were extended. (These processes include oil refining, hydrogenation of coal and tar to produce oil, hydrocarbon synthesis by the Fischer-Tropsch process, and low-temperature carbonization). Of these, oil refining is most likely to become a major source of methane.

Other possible ways of making methane are under investigation by the Gas Research Board and the Fuel Research Board. These methods include gasification of coal in hydrogen at high temperatures and under pressure, and synthesis of methane from gases containing carbon monoxide and hydrogen. While most of the research work on the latter process has been concerned with enrichment of water gas, it might also be used to increase the methane content of coal gas, provided that methods of removing organic sulphur are perfected, or that synthesis catalysts resistant to small amounts of sulphur are developed. One disadvantage in enriching coal gas is that the ethylene would almost certainly be hydrogenated to ethane by the synthesis catalyst, and would not be available for recovery.

It is clear from this brief review that the only established source of large quantities of methane in this country is in the gaseous products of carbonization. It has been mentioned above that the amount of methane in gas made by the Gas Industry is about 1.25 mill. tons per annum. Because of the reduced thermal yield of saleable gas per ton of coal produced and also of the change in combustion characteristics and calorific value of gas sold, removal of more than perhaps one-third of the methane from the gas at any one works could not be contemplated. Further, it would not be economic to remove methane or ethylene from the gas available at works below a certain size. A plant installed to remove one-third of the methane from a supply of 1,000 mill. cu.ft. per annum would produce about 4 tons per day of methane. About 70% of the gas sold is from undertakings selling this quantity of gas or more, so that, on the basis of the figures quoted, about 300,000 tons of methane would be separated per annum. If only one-tenth of this could be made available for chemical treatment it would be a most valuable contribution to the chemical industry.

It is by no means certain that separation of pure methane is essential before it is subjected to chemical treatment, but the nature and proportions of permissible impurities is a matter for experiment. Further, since the problems involved would be simplified with purer gas, a decision as to the extent of purification adopted might turn on an economic balance between the cost of purification and the increased cost of chemical treatment.

Methane is the least reactive of all the aliphatic hydrocarbons, but it can be converted to valuable products in a number of ways. Although ethylene is more reactive than methane, it is present in coal gas in much smaller proportion, and is likely to meet more serious competition from petroleum products than is methane. Moreover complete gasification processes will produce methane, but not ethylene. Consequently, rather more detailed information is given in this Paper regarding methods by which methane may be treated, than for the treatment of ethylene.

Treatment of Methane

Methane may be decomposed by the action of heat, with or without catalysts, or in an electric arc, and the process may be directed towards producing hydrogen, or acetylene, or ethylene. From the point of view of chemical industry, ethylene and acetylene are very valuable products, while appreciable quantities of the latter are also required for cutting and welding. In 1941, 60,000 tons of ethylene for plastics were made in the United States by pyrolysis of natural gas.

Published information with regard to the most suitable conditions to use, and the nature of the products obtained, is somewhat contradictory, but in general it appears that formation of acetylene is favoured by treatment at high temperatures (*e.g.*, over 1,300° C.) for short periods, while ethylene is produced at lower temperatures. Attempts to speed up or to direct the course of the reactions by the use of catalysts generally result only in increased decomposition of methane to its elements, so that, when ethylene or acetylene is required, non-catalytic decomposition is more suitable.

Decomposition of methane is greatly accelerated by the presence of higher aliphatic hydrocarbons, which crack to give suitable radicals. In particular, ethane is known to have a marked inductive effect.

During the war, acetylene was manufactured at one works in Germany on a scale of 120,000 tons per annum. Natural gas containing 90 to 92% of methane was passed through an electric arc, and unconverted gas was re-cycled. Each arc was operated at 7,000 volts and consumed 1,000 amps. This electrical input of 7,000 kW resulted in production of about 0.7 ton of acetylene per hr. The principal products obtained from 100 lb. of natural gas were:

	lb.
Acetylene	45.0
Ethylene	9.2
Carbon black	5.3
Hydrogen	12.0

The separation of the gaseous products was effected by low-temperature fractionation.

Processes for making acetylene from natural gas have been taken to the pilot plant stage in America; in one case an electric arc is used, and in another a regenerative furnace. It should be quite feasible technically to separate a methane-rich fraction from coal gas for treatment in an electric arc to give acetylene. Calculation shows, however, that the cost of acetylene manufactured in this way is likely to be 50 to 100% more than if made from calcium carbide.

Another possibility which has been examined is that of effecting cracking and polymerization of methane in one stage, so as to obtain liquid products. Thus, in one case of non-catalytic treatment at 1,200° C. 3% of the methane was converted to benzene, 3% to other light oils, and 6% to tarry material. In another case, natural gas and steam passed over iron, nickel and cobalt oxides at 5,000 lb. per sq. in. and 560° to 600° C. were found to give liquid hydrocarbon products. The general conclusion from information available, however, is that the temperatures required are high and the yields of desired products are only moderate under the best conditions so far found.

Oxidation

Methane can be oxidized in a variety of ways. Oxidation by steam gives a mixture of carbon monoxide and hydrogen, according to the equation:

$$CH_4 + H_2O \longrightarrow CO + 3H_2$$

This is a well-known reaction and can be used as an integral part of processes for production of gas, *e.g.*, for Fischer-Tropsch syntheses.

Direct oxidation of methane in a limited supply of air has been the subject of much research work. Theoretically, the following reactions can occur:

$$CH_4 + O \longrightarrow CH_3OH$$
$$CH_4 + 2O \longrightarrow HCHO + H_2O$$
$$CH_4 + 3O \longrightarrow HCOOH + H_2O$$
$$CH_4 + 4O \longrightarrow CO_2 + 2H_2O$$
$$CH_4 + O \longrightarrow CO + 2H_2$$

The last reaction has been found to proceed over a nickel catalyst at temperatures of the order of 850° to 1,200° C. The product can be used for hydrocarbon synthesis.

From the point of view of chemical industry, the first two reactions are the most important. Experimental work in America has shown that at 500° C. and a pressure of 135 atm. methyl alcohol formaldehyde and formic acid are produced. The ratio of methyl alcohol to formaldehyde varies from 3 : 1 up to 8 : 1, but when the temperature rises above 500° C. oxides of carbon tend to be formed. The gas used in these experiments contained some ethane, which apparently induced the oxidation reactions to commence at a lower temperature than when pure methane was used.

The possibility of catalysing these oxidation reactions has received considerable attention. Oxides of nitrogen, certain metals and metal oxides are particularly effective. Platinum is the most satisfactory solid catalyst, but vanadium oxide supported on pumice is almost as effective. Silver, copper, and palladium also have considerable catalytic activity for these reactions.

Considerable amounts of methyl alcohol and formaldehyde are being made at present in America by partial oxidation of natural gas. In 1941, between one-quarter and one-third of the total quantities used in the United States was stated to be produced in this way; although precise details of the process in use are not available, it appears that air and natural gas are compressed through the reaction zone and are cooled on leaving. The condensate is fractionated, while part of the gas stream is recirculated. Approximately equal amounts of methyl alcohol and formaldehyde are produced, while acetaldehyde and a little acetone are also formed.

Successful production of valuable products, in America, indicates the desirability of undertaking a serious study of the possibilities of partial oxidation of British supplies of methane.

Manufacture of Carbon Black

Carbon black can be manufactured from methane either by cracking or by partial oxidation. It is chiefly used as a filler in either natural or synthetic rubber, and is also used in ink and paints.

The quantity made in the United States is between 500,000 and 600,000 tons per annum, largely from natural gas. In this country the production is not known, but the quantity required in industry at present is believed to be quite small. It is considered that it would probably be more economic to use methane separated from coal gas for other purposes than the manufacture of carbon black.

The four chlorinated derivatives of methane are all valuable commodities, especially as solvents. Methyl chloride, CH_3Cl (b.p. $-24°$ C.), and methylene chloride, CH_2Cl_2 (b.p. 42° C.), are not made in quantity in this country at present. Chloroform, $CHCl_3$ (b.p. $-61°$ C.), is made at present by the chlorination of dry ethyl alcohol, followed by treatment with alkali, or by the action of bleaching powder on ethyl alcohol or acetone. Carbon tetrachloride, CCl_4 (b.p. 77° C.), is made by chlorination of carbon disulphide or coke. These substances have been used in America in connexion with chemical warfare and manufacture of synthetic rubber.

Reactions involved in direct chlorination of methane are all exothermic, commence in the dark at about 250° C., and proceed rapidly at 400° C. In addition to direct reactions, there is the undesirable possibility of carbon being formed by the reaction:

$$CH_4 + 2Cl_2 \longrightarrow C + 4HCl$$

This reaction takes place with explosive violence if the temperature exceeds 250° C. and neither of the reactants is present in excess. Apart from dissipation of the heat of reaction and the maintenance of an excess of either methane or chlorine, carbon deposition can also be avoided by addition of an inert gas to act as a diluent. The necessity of avoiding this reaction and of dissipating the heat of the various reactions are the major considerations in work on the chlorination of methane, and a variety of different processes have been examined. Since by choosing the appropriate methane: chlorine ratio any one of the four derivatives can be made the main reaction product, no process can be regarded as satisfactory which does not enable any methane: chlorine ratio to be used and at the same time avoid explosive reactions.

It has been stated that several plants are in existence, in the United States, for chlorination of methane, but information as to processes being operated is lacking. One of the processes is operated by the Dow Chemical Company, and patents taken out by this Company cover carrying out the reaction at 360° C. in a narrow space between two carbon walls not more than $\frac{1}{32}$ in. apart. In this way, a molecule which has reacted will collide shortly afterwards with the carbon wall, and the reaction chain will be broken.

A promising method described by H. B. Hass and E. T. McBee consists in the injection of chlorine into methane through a series of jets at a speed greater than that of flame propagation. By adjusting the number of jets and the volume of chlorine admitted, any desired methane: chlorine ratio may be used without explosion occurring. The reaction tube was immersed in a salt bath, and 440° C. has been found to be a suitable reaction temperature under these conditions. A patent assigned to the Darco Corporation proposes to pass the reacting gases upwards through a catalyst bed, which consists of material of low catalytic activity and high thermal conductivity at the base, and of high catalytic activity and low thermal conductivity near the top. The bottom of the column is maintained at about 280° C. by cooling, both by means of internal pipes and external sprays, while the top of the column is maintained at 400° to 450° C. by electrical heating.

Since the end of the war, information has been obtained regarding a plant in operation in Germany for the production of 500 to 600 tons per month of methylene chloride and 100 to 150 tons per month of chloroform. Coke oven gas was separated by liquefaction. The methane fraction contained small amounts (about 0.6%) of ethylene which were hydrogenated to ethane prior to chlorination of the gas.

The chlorination plant consisted of seven chlorinators, each 5 ft. in diameter and 13 ft. high, made of cast iron and lined with cement. The lower 85% of each chlorinator was enclosed in a brick furnace fired by gas burners situated near the base, and the temperature in the vessels was maintained at 370° to 390° C. The top 3 ft. of each chlorinator was filled with Raschig rings, and the methane and the chlorine (5: 1 by volume), which had been brought together prior to entry into the vessel, were discharged vertically downwards near the centre. The reaction products left at the top of the vessel. Hydrogen chloride was separated from the products by washing with water and then with caustic soda. The chlorinated methanes were then separated from unconverted methane by refrigeration, and from one another by fractionation.

Before the war, chlorine could be bought at £19 per ton in this country and £8 per ton in the United States. Although half the chlorine is converted to hydrogen chloride during chlorination of the methane it could be recovered, for example, by Deacon's or Weldon's process. The value in this country of the chlorinated derivatives of methane before the war varied from about £35 per ton for carbon tetrachloride up to about £330 per ton for methyl chloride. Assuming that methane could be isolated by liquefaction and were available at £20 per ton (1938 figure), an adequate margin should be available for the cost of processing methane with chlorine, even when allowance is made for a considerable fall in the value of the more highly priced products when the market becomes saturated.

Nitration

It has recently been reported that natural gas freed from all hydrocarbons other than methane has been successfully nitrated in laboratory experiments by the direct action of 67% nitric acid at 375° to 600° C. The most successful experiment was at 475° C. and with an exposure time of 0.18 sec. Using a ratio of 9 mol. of methane to 1 mol. of nitric acid, 13% of the acid was converted to nitromethane in one pass.

Nitromethane is a reactive liquid boiling at 101° C., and would be useful as a solvent and in the manufacture of explosives, emulsifying agents, pharmaceuticals, dyes, rubber accessories, photographic developers, chemicals, &c. Direct conversion of methane to this material therefore merits further study, particularly as regards construction of an apparatus to operate under the type of conditions indicated above.

Carbon disulphide is a valuable solvent itself and can also be used for the manufacture of carbon tetrachloride. Experimental work has shown that it is formed when methane is treated with hydrogen sulphide at 1,080° to 1,280° C. by the following reaction:

$$CH_4 + 2H_2S \longrightarrow 4H_2 + CS_2$$

Using gas containing 80% methane, 8% of other hydrocarbons, 11% of nitrogen and 1.4% of carbon monoxide in a quartz tube, the best result was obtained using a mixture containing 70% of hydrogen sulphide. 55% of the hydrogen sulphide was converted when the temperature was 1,180° C. and the reaction time 0.4 sec. The amount of carbon formed was 0.014%, and the tarry matter was 0.3% of the total weight of reacting gas.

Although the temperature used in these experiments is high, conversion is promising and further work is desirable. Direct action of sulphur on methane, possibly under pressure, also merits consideration.

Hydrocyanic acid is a useful chemical for a number of purposes. In particular, chemical industry requires it to prepare such substances as acrylonitrile. It has been shown that it can be made from methane by three different reactions. The reaction most examined is the slightly endothermic one:

$$CH_4 + NH_3 \longrightarrow HCN + 3H_2$$

This is best carried out in the absence of added catalysts, since they tend to favour carbon formation. At 1,500° C. with a time of contact of 0.5 sec., 65% of the ammonia and 32% of the methane is converted in one pass, using a mixture of two parts of methane to one of ammonia.

An alternative method is to use sufficient air or oxygen to oxidize the hydrogen to water:

$$2CH_4 + 2NH_3 + 3O_2 \longrightarrow 2HCN + 6H_2O$$

At 1,000° C. and using a platinum gauze catalyst, about 60% of the methane in a stoichiometric mixture is converted at a gas velocity of 15 ft. per sec.

Laboratory experiments have shown that, under the influence of a high-frequency arc, methane can be made to react directly with nitrogen, according to the equation:

$$CH_4 + N_2 \longrightarrow HCN + NH_3$$

The yields, however, are poor, a typical result being 27 g. of hydrogen cyanide and 3 g. of ammonia per kWh.

(To be continued)

COMPANY MEETINGS

Gas Consolidation, Ltd.

A Progressive Record

Difficulty of Long Term Planning

The Twelfth Annual General Meeting of Gas Consolidation, Ltd., was held on Sept. 3 at 15, Moorgate, London, E.C.

Sir LESLIE BOYCE, K.B.E., who presided, said: Gentlemen,—I regret to say that our Chairman, Major Julian Day, has had a serious illness which prevents him from being present at this meeting. But for his initiative it is more than probable that this company, and its close associate, Severn Valley Gas Corporation, would never have been formed. It is certain that much of their steady progress since incorporation is due to his vigorous outlook and capable guidance of our affairs. I feel sure that, in wishing him a complete recovery of his former good health, I am expressing the thoughts of us all.

The accounts for the financial year to May 31 last show results very similar to those of the previous year. Although there are some minor changes in the individual items comprising the revenue account, the net profit available for distribution, after providing for debenture interest and income tax, is £22,237—almost exactly the same amount as was earned for the year ended May, 1945.

The directors recommend the payment of final dividends of 2½% and 3% (less tax) on the "A" and "B" Ordinary stock respectively, making dividends of 5% (less tax) for the year on both classes of stock. Dividends at the same rate have been paid each year since 1940 although during this period certain undertakings in this group have been obliged to vary their annual dividends. The parent company has therefore exercised a stabilising influence which has benefited our stockholders. After providing for the dividends recommended, the balance carried forward is £22,349, which compares with £19,077 brought in at the beginning of the year.

There are no items in the balance-sheet that call for comment. No new subsidiary undertakings have been acquired during the year, the slight increase in investments representing the purchase of additional small holdings in companies already within the group.

Labour and Materials Shortage

In July last, I had the pleasure of addressing the stockholders of our associated company, Severn Valley Gas Corporation, which, as you are probably aware, controls and manages a similar group of gas undertakings and shares with this Company the same central organization. Some of the remarks I made at that meeting are pertinent to the affairs of Gas Consolidation and, therefore, I propose to refer to them.

During the war years, the severe shortage of labour and materials made the efficient operation of our gas undertakings a very difficult task and normal maintenance work could not be carried out to the extent that we should have wished. In a number of instances, this difficulty was further accentuated by a substantial increase in the demand for gas. The fact that our undertakings were able to meet all the demands made on them reflects the greatest credit on all concerned.

Success of Board's Policy

The first subsidiary undertakings were acquired in 1934 and during the next five years we progressively added fresh companies to the group. But for the outbreak of war it is only natural to assume that further expansion on these lines would have continued. For the greater part of the time that this Company has been in existence the Gas Industry, and the whole nation for that matter, has been faced with difficulties and restrictions which would have been considered in pre-war days to be quite insuperable. Despite such adverse conditions, we have had ample proof that the policy we have endeavoured to pursue is the one from which the undertakings and their consumers will derive the most benefit.

The expansion of our undertakings is clearly shown by the fact that the total quantity of gas sold by this group in the year 1945 was just over 62% in excess of the quantity sold by the same companies at the time of acquisition. During the comparable period the increase in the sales of gas for all undertakings in this country is officially stated to be 19%. I think we may be justifiably proud of this record.

Cost of Coal

Other notable results have been achieved. The average price received per therm of gas sold has risen by only 14% although the average price of coal has increased, during the same period, by 117%—namely, from 20s. 11d. per ton to 45s. 4d. per ton. All other items affecting costs of production and distribution, for example, labour and materials, have shown equally sharp rises.

The efficiency of an undertaking and the price of gas charged to its consumers is, to a great extent, dependent upon the quality and cost of the basic material—coal. I have already stated that the Gas Industry has been compelled to pay a very much increased price for its coal, and, in addition, it has been compelled to accept a considerable deterioration in quality. Naturally, this deterioration is a matter of very serious concern to the Industry. The position has been aggravated still further by reason of the fact that individual undertakings are not allowed a free choice of the coal they are to receive. Despite frequent appeals, the authorities cannot be convinced that the various types of gas-making plant were designed to carbonize particular grades of coal. Thus, the incongruous situation arises of two neighbouring undertakings both being obliged to take delivery of coal which is quite acceptable to one although entirely unsuitable for the carbonizing plant of the other.

We have all read and heard frequent announcements from Mr. Shinwell, the Minister of Fuel and Power, and the other members of the present Government on the gravity of the coal situation. Since the decision to nationalize the coal industry was announced, the quantity of coal reaching the surface has declined and the general public has been warned that there will be an acute shortage of coal throughout the country during the coming winter. We are most concerned as to the stocks of coal at the works of our companies. At the end of our financial year in May last our coal stocks averaged no more than 2.6 weeks' demand; compared with this, in May, 1939, we had on the average stocks equivalent to some six weeks' demand. We are therefore in a very precarious position and there appears to be no hope of any material improvement. If the winter is a severe one, it will be most difficult to avoid a breakdown in the supply of gas through lack of coal.

Threat of State Ownership

Shortly after our last annual meeting the Government announced their intention to transfer the Gas Industry to State ownership. They propose that both municipalities and companies should be compulsorily dispossessed of the undertakings which they have built up by their own enterprise during a century of public service. It has not been claimed that those undertakings have been inefficient under their existing owners and, in the eight months since the Government's proposal was announced, the Gas Industry, its consumers and the nation have awaited some indication as to what benefits nationalization is intended to bring. There has, so far, been no attempt to show the need or the justification for the compulsory transfer; nor has there been any indication of a constructive plan.

Under company and municipal ownership many of the less efficient works were closed down before the war and supplied in bulk. That process of integration proved advantageous both to the Industry and to its consumers. It will undoubtedly be continued in the future, whoever owns and controls the Gas Industry. At the present time, however, the nationalization proposals have removed the basis for long-term planning, and have offered nothing in its place. Much essential work is held up, while other work now proceeding is likely to prove wasteful through lack of effective co-ordination. An example of this is the costly reconditioning or enlargement of gas-works in different parts of the country that may be permanently closed down in the near future.

Heavy Demands Met

Heavy demands made on the Gas Industry during the war were courageously and effectively met; but plant was overworked and deferred replacements and extensions should be put in hand without delay. Were it not for the threat of nationalization it would have been possible to raise new money for this deferred work on most favourable terms. The spending of this money would, in turn, have been to the advantage of the future owners. Since December last the Government have been pressed to give assurances as to the repayment of the money thus expended, and the British Gas Council have been engaged in protracted negotiations with the object of securing such assurances; but, so far, none has been forthcoming.

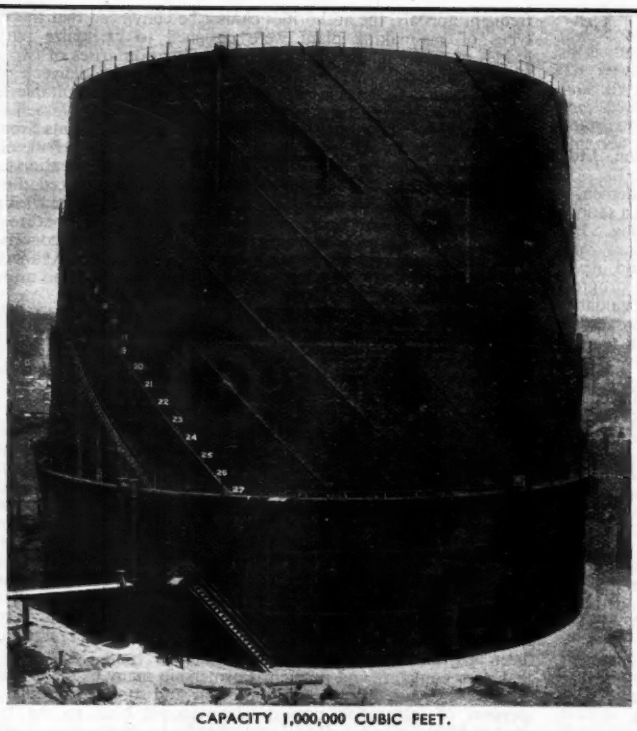
The Lord President of the Council, when first referring to the nationalization of the gas and electricity industries, stated in Parliament on November 19 last: "All necessary development in the industries must proceed. The Government, therefore, propose to see that progressive undertakings will not be prejudiced if they continue to develop in the interim period."

That policy does not appear to have been embodied in the Coal Industry Nationalization Act. If the Government are willing to ensure that expenditure officially approved by them should cause no ultimate loss to stockholders in the Gas Industry, an undertaking to that effect by the Minister of Fuel and Power would be welcomed, and would enable essential work to be put in hand.

The Problem Remains

Whether or not nationalization is eventually forced upon the Gas Industry, the practical problem will inevitably remain the same. Although we already provide the most economical method of using the heat content of coal, our researches are continually directed to increased efficiency; greater administrative economy would be achieved by integration in larger units; the supply of gas in bulk, both from large gas-works and from coke ovens, could be developed still further with advantage; and a complete overhaul of the antiquated legislative harness which shackles the Industry is long overdue. All these matters call to early action in the public interest.

Whoever may own the Industry in the future, its standard of public service will depend on the men who operate it. Whether the machine is to work well or ill, will be largely determined by the initiative, enterprise and skill of the managers, engineers, chemists, foremen, fitters, stokers and the like. Here is a fundamental human problem too apt to be overlooked. The industry is well served to-day, but



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GAStrology

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FEBRUARY 21 — MARCH 20. PISCES — THE FISHES

The Luminaries rising in the scene of Aquarius, with Mars and Jupiter in opposition and high tide at Wigan 1 hr. 58 min., a.m. all suggest gratifying prospects for you. Well, look a bit pleased, can't you? Pull onions tops and prick out cabbages now, also beware of a tall dark stranger. About the 24th your in-laws will cause trouble but when did they ever cause anything else? A political reaction in the Inner Hebrides will cause iron and steel shares to slump on the New York Stock Exchange. Wind will be N.N.W., backing and veering and fooling about all over the place.

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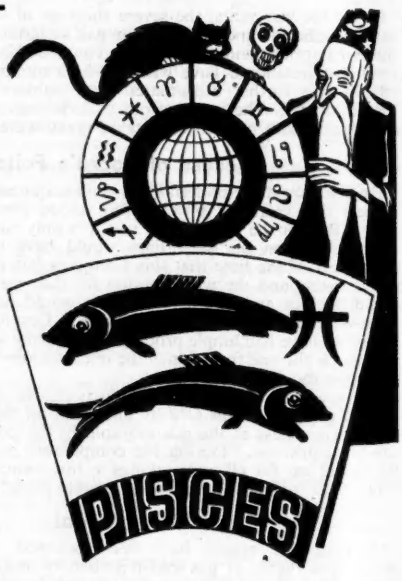

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its personnel of to-morrow are the recruits of to-day. Can it be said that, under nationalization, it would be as likely to attract young men of initiative, enterprise and skill ?

Discouragement of Employees

An example of discouragement to the best type of personnel is to be found in the Coal Industry Nationalization Act. This provides that all contracts of employment may be transferred without the consent of the men concerned, and that the new owners may repudiate any contract made or varied after the announcement of the nationalization proposals. If it be a service contract, the employee is denied the right to appeal to arbitration unless he can first obtain the express consent of the Minister of Fuel and Power. Moreover, he is not given a right to be heard when applying for such consent, nor is the Minister required to state any reason for withholding it. Thus, an official given well-earned promotion cannot rely on having his service contract maintained, and will not be entitled to speak in defence of the appointment on which his livelihood depends.

Your Directors are conscious of the duty they owe to those engaged in the Industry as well as their duty to the stockholders. We are, therefore, seriously concerned to see that the rights and interests of both are properly safeguarded for the future. The Association of British Chambers of Commerce, which is representative of a great number of gas consumers throughout the Kingdom, has declared strongly against State ownership on the ground that " the consumer will be the ultimate loser." As the stockholders and those engaged in the Industry also clearly stand to lose, it is difficult to see who is expected to gain.

In the proposals for the rationalization of gas your Company and other members of the Association of Gas Corporations are vitally concerned, not only as gas stockholders, but also as an active component of the Industry. They have much practical and successful experience of the integration of gas undertakings, this being the main object for which they were formed. The Ministry of Fuel and Power have agreed that discussions with the Association should take place at the appropriate time, and the Directors will do their utmost to ensure that in these discussions, and, if necessary, in Parliament, your interests are properly represented. It is sometimes overlooked, even in the Gas Industry, that it is Parliament, and not the Government, which makes new legislation.

Board and Management

Colonel C. P. Dawnay, who was closely associated with our activities before the war, has now returned after distinguished service in the Army. He has been appointed to fill a vacancy on the Board and we welcome the valued assistance he is able to give us. The Company's solicitor, Colonel R. H. Studholme, has also returned to us and considerably strengthens our organization.

For reasons of health Mr. G. M. Gill resigned his position as Managing Director on April 1 last. Since its inception Mr. Gill has rendered exceptional services to the Company and taken a very active and responsible part in its growth and successful operation. I have already referred to the notable progress made by this Company, much of which is due to Mr. Gill's untiring energies and outstanding ability. We welcome the fact that Mr. Gill will continue as a Director of the Company and as our Consulting Engineer.

For his distinguished service as gas adviser to the Ministry of Fuel and Power the honour of knighthood has been bestowed upon Sir George Evetts. We all heartily congratulate him on this honour which he has so richly deserved. In conclusion, I must express the thanks which are due to Mr. R. S. Snelling, our general manager, and to all officials, staff and employees of the central organization and constituent companies whose efforts and loyal co-operation have our full appreciation.

The report and accounts were adopted.

MALTA AND MEDITERRANEAN GAS COMPANY

The Annual General Meeting of the Malta and Mediterranean Gas Company, Ltd., was held at the offices, 5, Great Winchester Street, Old Broad Street, London, E.C.2, on Aug. 30 1946. Mr. Arthur M. Paddon, M.Inst.C.E., Chairman of the Company, presided.

The MANAGING DIRECTOR and SECRETARY, Mr. G. Murray Burton, M.A., F.C.A., read the notice convening the meeting and the report of the Auditor.

The CHAIRMAN said: I may say for the information of the proprietors that I think it will be found that the accounts which we have to present are both satisfactory and reassuring in their character. I propose to refer briefly to the more pertinent points in the accounts. If they are referred to they will show that coal, oil, and raw materials have cost £5,957 more. On the other side of the revenue account it will be seen that the sale of gas has increased by £8,613, and the rental of meters and stoves by £680, which is a very sensitive entry, because it really indicates the progress that the Company is making in acquiring new business since the reconstruction. Residual products have also increased by £1,510 to support the general result, which is a profit of £4,221 on the revenue side of the account. That figure is somewhat at variance with the general nature of the report, in that it is £1,572 less than the profit shown on the previous occasion. That is due to the fact that the revenue has contributed in a somewhat greater degree to the rehabilitation of the Company's business.

Turning to the Profit and Loss Account it will be seen, to epitomize the results, that whereas we brought a balance of net profit of £4,319 into the right hand side of the account, we are carrying forward £4,667 by way of undivided profits, which represents a very creditable and satisfactory position.

Coming to the Balance Sheet, perhaps the most salient feature is the amount of the investments in trustee securities to the credit of the Company, which have a book value of £34,500, and on the valuation at the date appertaining to these accounts a value of £53,000, which shows a very material appreciation. On the other side of the account it will be seen that while the Company's authorized capital is £150,000 we have only employed, in earning the profits distributed, a sum of £44,310, a fact which has a very stabilizing effect at the moment, and especially for the future. The reserves stand at £83,511, and you will see in the account that there is some provision for taxes. It will also be seen that sundry creditors and accrued expenses amount to £7,018, while sundry debtors and payments in advance amount to £10,110; that, of course, is a very favourable comparison.

Proprietors will want to know something about the immediate prospects of the Company. It may be inferred from the statement submitted that we have made good progress in restoring the position of the Company as a profit-earning undertaking. That process still goes on, and the relation between revenue and expenditure and profit is likely to be more favourable in the future as this process is carried forward. We have friendly relations with the Governmental authorities in Malta, and I think we stand well with the public, but we shall be unremitting in our endeavours to create more intimate and more satisfactory relations with the public than have obtained during wartime and even before the war. I think we can look forward with confidence to the results for the coming year, although these are uncertain times and it is difficult to form definite estimates. Nevertheless the prospect is better than it was 12 months ago, and we see no particular reason why it should be disturbed. I now beg to move that the report and accounts be adopted.

Mr. FRANK H. JONES seconded the resolution, which was carried unanimously.

The CHAIRMAN: I now beg to propose: " That final dividends at the full rates be declared on the First and Second Preference Stock, and a dividend of 2½%, free of income tax, on the Ordinary Stock, making for the year, with the interim dividend paid in April last, a total distribution of 7% on the First Preference Stock, 7½% on the Second Preference Stock, and 5%, free of income tax, on the Ordinary Stock."

Commander HYDE C. BURTON, F.C.A., seconded the resolution, which was carried unanimously.

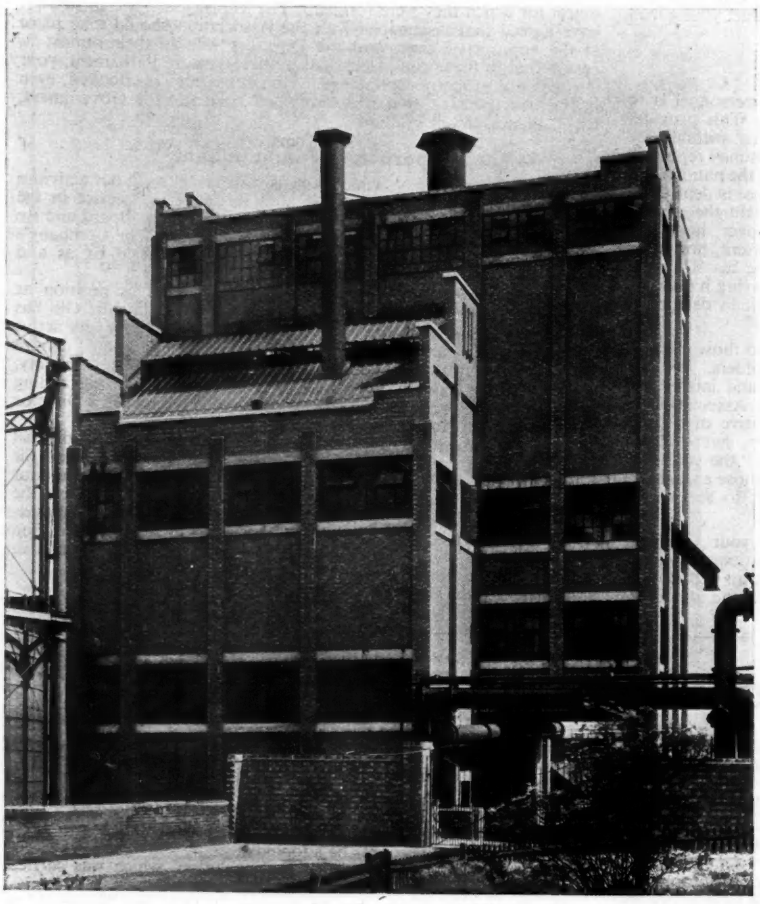
The CHAIRMAN proposed the re-election of Commander Hyde C. Burton, F.C.A., as a Director of the Company, and Sir GEORGE EVETTS seconded. Commander Burton was unanimously re-elected.

On the proposition of Mr. FRANK H. JONES, seconded by Sir GEORGE EVETTS, Mr. William Cash, Junr., F.C.A., was re-elected Auditor.

The CHAIRMAN: That concludes the normal business of the meeting, but it is fitting on this occasion that we should accord a vote of thanks to our staff, both here and in the Mediterranean. I need not enlarge on their difficulties, for it is public knowledge that they have been very great, and those difficulties have been met in a very satisfactory manner in every case; that is evidenced in the figures which we are able to present to this meeting. In the first place we should like to record, in this resolution, that we are very greatly indebted to our Managing Director, Mr. G. Murray Burton. In the old days we were to a certain extent sequestrated from our business, and it was not so easy to make contact with our works at Malta as it is to-day. But Mr. Burton has availed himself of modern methods of contact, and he has visited Malta and he is shortly going to do so again. His visits are an important contribution to the successful administration of the Company. I know the proprietors would like to convey to the staff in Malta their appreciation of the special efforts in the abnormal circumstances arising as a result of the war. The damage sustained out there has already been referred to at some length at previous meetings, and I will simply say that we appreciate to the full all the difficulties they have had to contend with and offer them our heartfelt recognition of their services. May I also add that we express our expectation of a continuance of those services.

The vote of thanks was seconded by Mr. FRANK H. JONES, supported by Sir GEORGE EVETTS, and carried unanimously.

Mr. G. MURRAY BURTON briefly acknowledged the vote of thanks on his own behalf and undertook to convey it to the staff at home and in Malta.



GLOVER-WEST

Vertical Retorts

at

HIGH WYCOMBE

ARCHITECTURAL FEATURES

From the layman's point of view, perhaps the most interesting feature is the attempt to produce in an essentially industrial building a pleasing architectural appearance. The steel frame-work of the building has been encased in brickwork, and the coal-receiving annexe and coke hoppers are built as integral features of the main building. A liberal use has been made of steel-framed windows for producing maximum natural lighting and ventilation. Parapets with "Snowcrete" coping form a pleasing finish to the skyline. Rain-water pipes are not visible, being taken down internally. The full effect of the building when viewed from Desborough Road is masked to some extent by the abutment of the old horizontal retort house, but when this is dismantled and the new retort house extended it will appear as an independent and symmetrically designed structure.

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GAS PRODUCTS PRICES—STOCKS AND SHARES

The London Market

September 10.

From July 15 there has been an increase of 5s. per ton in the price fixed by the Coal Tar Controller for Coal Tar Pitch in bulk or solid form for the manufacture of Patent Fuel in the home market.

The price thus became 75s. per ton free on rail/road waggon/barge or ship, at Makers' Works.

There are at the moment no changes to be recorded in the prices of Coal Tar products.

The Provinces

September 10.

Average prices of gas-works products: Pitch, 70s. per ton; toluole, naked, North, 90's, 2s. 4d. to 2s. 6¾d. per gallon; pure, 3s. 2¼d. Prices for carbolic acid 60's, anthracene, creosote oil (hydrogenation), coal tar oils (timber preservation, &c.), and strained anthracene oil are controlled by Government Orders. Prices for road tar were increased by a half-penny per gallon by S. R. & O. 1945, 229, under which Order there was also an increase of 5s. per ton in the price for standard creosote-pitch mixture.

Scotland

September 7.

Export demand continues in excess of supply.

*Refined Tar.** Yield to the Distiller is 5d. per gall. ex works, naked. *Creosote Oil.* Timber preserving quality,* 5½d. to 6½d. per gall.; Hydrogenation Oil,* 5⅞d. per gall.; Low Gravity or Virgin Oil,† 7½d. to 7½d. per gall.; Benzol Absorbing Oil,* 6½d. to 8d. per gall. *Refined Cresylic Acid** is 3s. 6d. to 4s. 6d. per gall. ex works, naked, according to quality. *Crude Naphtha,†* 7d. to 8d. per gall. *Solvent Naphtha.** Basic maximum prices delivered in bulk, 90/160 grade, 2s. 10d. per gall, and 90/190 Heavy Naphtha, Unrectified, 2s. 0½d. per gall.; Rectified, 2s. 4d. per gall. *Pyridine,†* 90/160 grade, 15s. per gall., and 90/140 grade, 17s. per gall.

* Price controlled. † Uncontrolled.

The week opened cheerfully with British Funds the chief feature, but later the heavy fall in Wall Street led to a widespread decline in prices in practically all sections outside the gilt-edged market. On Thursday many of the leading industrials recorded quite substantial falls, although following the overnight rally on Wall Street prices were marked up on Friday. Buyers remained cautious, however, and the opening prices were not all held.

The Gas Market continued quiet throughout the week with fewer price changes than for some time past. It has been particularly noticeable that while values in most sections suffered a relapse the "nationalization" stocks were very little affected. On the Local Exchange Bristol 5% maximum recovered a fraction while Gas Light units and Commercial ordinary closed lower.

The following were the few price movements up to Thursday last:—

OFFICIAL LIST.

Commercial ord.	70 — 75	–	1
Gas Light units	20/9—21/9	–	3d.
Imperial Continental...	105 —110	–	2
South-Eastern Gas Corpn. 4 p.c. cum. pref.	19/3—20/3	–	3d.

PROVINCIAL EXCHANGES.

British 5 p.c. max.	114 —116	+	½
Sheffield cons. ..e ... ... xd	133 —137	Aug.	25

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